Stainless Steel
ARCHITECTURAL FACT SHEET

Prepared by The International Nickel Company, Inc., in cooperation with Committee of Stainless Steel Producers, American Iron and Steel Institute

United Engineering Center, New York, N. Y.
Architects: Shreve, Lamb and Harmon

Stainless steel is a series of steel alloys which includes at least 11.5 percent chromium. For architectural work the 300 series (18/8 chromium-nickel grades) are generally used. Because of its appearance, strength and high corrosion resistance, stainless steel is finding increasingly wide use in architecture for both exterior and interior applications. This fact sheet has been prepared to give architects and architectural students most of the basic data they will need to put stainless steel to work effectively. The following pages provide information on the characteristics of the metal, the forms in which it is available, alloys and finishes commonly specified for architectural purposes, and suggestions on design and maintenance.

For further information on stainless steels and additional supplies of this Fact Sheet, contact Committee of Stainless Steel Producers, 633 Third Avenue, New York 17, N. Y.

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Rising to a height of 630 feet, Jefferson National Expansion Memorial in St. Louis, Mo., is faced with Type 304 stainless steel plates with a polished finish. Because of stainless' resistance to corrosion and weathering, the gleam of the catenary arch, visible for over 30 miles, will be permanent.
Architect: Eero Saarinen.

Why design in Stainless Steel?

Stainless steel has certain inherent advantages that make it ideal for a wide variety of architectural applications. Chief among these is its resistance to corrosion. Under normal conditions, stainless will not corrode, pit, tarnish, or deteriorate in any other way. There is no need to compensate for loss of strength due to deterioration, and replacement costs are virtually non-existent.

From the esthetic viewpoint, stainless is notable for its inherent beauty and the ease with which it blends with other materials. It has a subtle sheen which does not overwhelm or intrude on other design and color elements; rather, it complements, reflects and highlights surrounding materials. Because of its corrosion resistance, its appearance is permanent, and there is no danger of corrosion products streaking or staining other materials.

Stainless is among the strongest of metals. Tensile strengths of 75,000 to 125,000 psi (or higher if needed) permit the use of delicate, thin-line members where desirable, and allow the use of gauges much lighter than are usually needed in other metals. Sturdy design elements, fabricated from thin sheets of stainless, can combine light weight with strength. High structural value can accommodate esthetic design in floating stairways, grilles and similar decorative applications.

A corollary of stainless' high life expectancy is the ease with which it can be maintained. In an urban or industrial atmosphere all that is generally needed is a washing with detergent and water or with one of the commercial stainless steel cleaners. This can often be handled in the course of the regular window washing operation. In many circumstances, however, washing can be left to the action of rain and wind, with no fear that the metal will deteriorate. Savings that accrue from the low cost of maintaining stainless can make up any difference in cost that may appear between components made of stainless and other materials. Result: in the long run, stainless is one of the most economical of architectural metals.

Stainless steel is produced in virtually all standard metal forms and sizes, plus many special shapes. Sheet and strip stainless are the products most often formed into architectural components. The designation <u>strip</u> is used for widths of metal less than 24 inches, while <u>sheet</u> refers to 24 inch and greater widths. Sheet and strip forms are available in practical architural thicknesses from .010 inch and up (or as low as .001 inch for special applications). Heavier plate material is also available, over 10 inches in width and 3/16 inch and over in thickness.

Stainless steels are also produced in the form of tubing—round, oval, square, rectangular and hexagonal, both welded and seamless. Welded tubing is made up to 30 inches in diameter, seamless up to 8 inches. Other available forms include bars and rods of similar shapes as well as wire and extrusions.

Thickness of Stainless Steel used in architectural applications

STREET LEVEL APPLICATIONS

column covers, fascia panels, mullions, pilasters—stiffened with braces, but not completely backed up, doors, kick plates

ABOVE STREET LEVEL APPLICATIONS

Curtain walls, spandrels, mullions, windows, flashing, roofing, louvers

U.S. Standard Gauges	Approximate Weights (in pounds per sq. foot)* Blue bars indicate edge thickness of Gauges	Nominal Thickness in Inches	END USES†
10	5.906	.141	Monumental ornamental
			Elevators and escalators
11	5.250	.125	Door bumpers
			Thresholds
12	4.594	.109	Cover plates
			Kick plates
			Column covers
14	3.281	.078	Convector covers
			Large mullions
16	2.625	.063	Unbacked fascia
			Door sections
18	2.100	.050	
			Light mullions
20	1.575	.038	Window sills
22	1.312	.031	Window framing
24	1.050	.025	Cleats, clips
26	0.787	.019	Louvers, gravel stops, formed and laminated panels
28	0.656	.016	Roofing, exposed flashing, gutters
32	0.426	.010	Concealed flashing

* Type 300 Cr-Ni Series.

† These end uses are listed as a general guide with only approximate relation to gauge thickness. For specific recommendations, consult a fabricator or stainless steel producer.

Alloy Type Designations

302 is the basic chromium-nickel austenitic stainless steel and has been found suitable for the widest range of applications in all kinds of architectural work. It is the most readily available in a variety of forms. This type is easy to form and fabricate with excellent resistance to corrosion from exposure to weather. It is the grade which is normally used for exterior architectural applications.

301 is a variation of 302 which can be cold rolled to high tensile strengths for special applications. This is primarily in strip form, for flashing products.

304 is a low carbon variation of 302 having slightly higher corrosion resistance. It is sometimes specified where extensive welding of heavy sections will be done.

316 offers more corrosion resistance through the addition of molybdenum. This type is desirable where severe corrosion conditions exist, as in salt water and heavy industrial atmospheres.

201 and **202** are chromium-nickel-manganese austenitic stainless steels having virtually the same properties as 301 and 302.

430 is a chromium ferritic stainless steel with lower corrosion resistance than the 300 or 200 series. It is principally employed for interior use.

305 and **410** are used for bolts, nuts, screws, and other fasteners.

REPRESENTATIVE MECHANICAL PROPERTIES (Annealed sheet)

	Type 302	Type 301	Type 304	Type 316	Type 201	Type 202	Type 430
Yield Strength (psi)	40,000	40,000	42,000	40,000	55,000	55,000	50,000
Tensile Strength (psi)	90,000	110,000	84,000	84,000	115,000	105,000	75,000
Elongation in 2"	50%	60%	55%	50%	55%	55%	25%
Hardness, Rockwell	B-85	B-85	B-80	B-79	B-90	B-90	B-85

OTHER PROPERTIES (Annealed sheet)

	Type 302	Type 301	Type 304	Type 316	Type 201	Type 202	Type 430
Modulus of Elasticity (psi in Tension)	28.0×10^6	28.0×10^6	28.0×10^6	28.0×10^6	28.6×10^6	28.6×10^6	29.0×10^6
Density (lb./cu. in.)	0.29	0.29	0.29	0.29	0.28	0.28	0.28
Mean Coefficient Expansion per degree F (32-212° F)	9.6×10^{-6}	9.4×10^{-6}	9.6×10^{-6}	8.9×10^{-6}	8.7×10^{-6}	9.7×10^{-6}	5.8×10^{-6}
Thermal Conductivity BTU/hr./sq. ft./degree F/ft. (212° F)	9.4	9.4	9.4	9.4	9.4	9.4	15.1

These Niagara River Power Project intake gate structures, each nearly 100 feet high, are clad with stainless steel panels for strength and stability in a corrosive environment. A special low-reflective architectural matte finish gives the panels an attractive sparkle without optical distortion.

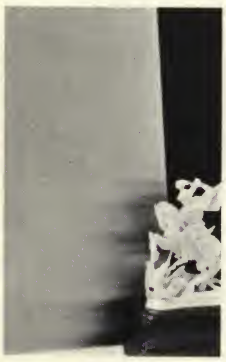
Engineers: Uhl, Hall and Rich

Sheet Finish Designations


No. 2D Finish


No. 2B Finish

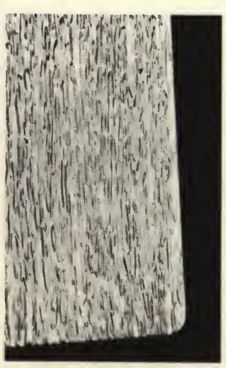

Architectural Matte Finish


No. 4 Finish


No. 6 Finish


No. 7 Finish


Fabricator's Satin Finish


Textured Finish

Unpolished Finish (Rolled) No. 1 †	A dull finish produced by hot rolling to the specified thickness, followed by annealing and descaling.
Unpolished Finish (Rolled) No. 2D* †	A dull finish produced by cold rolling to the specified thickness, followed by annealing and descaling. May also be accomplished by a final light roll pass on dull rolls.
Unpolished Finish (Rolled) No. 2B* †	A bright finish commonly produced in the same way as No. 2D finish except that the annealed and descaled sheet receives a final light cold roll pass on polished rolls. This is a general purpose cold rolled finish, and is more readily polished than the No. 1 or No. 2D finishes.
Rolled Finish Matte	A non-reflective finish produced in the mill through the use of specially prepared rolls.
Rolled Finish Scratch	A simulated polished finish produced in the mill by cold rolling.
Polished Finish No. 3 †	An intermediate polished finish generally used where a semi-polished surface is required for subsequent finishing operations following fabrication.
Polished Finish No. 4 †	A general purpose bright polished finish obtained with a 120-150 mesh abrasive, following initial grinding with coarser abrasives.
Polished Finish No. 6 †	A soft satin finish having lower reflectivity than No. 4 finish. It is produced by Tampico brushing the No. 4 finish in a medium of abrasive and oil.
Polished Finish No. 7 †	A highly reflective finish produced by buffing a surface which has first been finely ground with abrasives, but "grit" lines are not removed.
Polished Finish No. 8 †	The most reflective finish commonly produced. It is obtained by polishing with successively finer abrasives, then buffing extensively with a very fine buffing compound to remove essentially all "grit" lines.
Specials	A wide variety of polished, embossed, patterned, textured, engraved and coated finishes are available on special inquiry.

* No. 1 and 2 finishes for strip (widths under 24") approximate No. 2D and 2B sheet finishes respectively, in the corresponding alloy types.

Note: For further information and literature about stainless steel contact the Committee of Stainless Steel Producers, AISI, 633 Third Ave., New York 17, N. Y.

† As designated in the Steel Products Manual "Stainless and Heat Resisting Steels," AISI.

Designing in Stainless Steel

As with any material used in building, the cost of stainless steel construction varies depending on design requirements and solutions. Costs will be higher for elaborate, unique or complex detailing than for simplified, standardized designs. Thus stainless structures can range from quite costly to most economical. The following recommendations will be helpful in achieving economy in stainless steel designs:

1. Design hollow sections in shapes which can be fabricated by common sheet metal techniques (see below). Simple straight-line bends are easy to form; avoid short return bends or jogs, which make fabrication difficult.

2. Reduce gauge. Research reveals that Type 302 stainless steel sheet, for example, has at least three times greater tensile strength than aluminum sheet. Architects can take advantage of this strength by reducing gauges.

3. Metal thickness can be reduced by designing formed sections, or by using textured or die-pressed sheet for broad areas.

4. Design self-framing units to eliminate the need for structural steel back-up, which adds weight and cost.

5. Where possible, incorporate commercial parts and details standardized by fabricators. Elaborate custom detailing naturally costs more.

JOINING CONSIDERATIONS

Stainless steels are readily welded, and, unlike most other materials, the work area can be blended for uniformity of appearance when polished finishes are used. Spot welding, on the other hand, has little effect on the surface, and refinishing is minimized or completely eliminated.

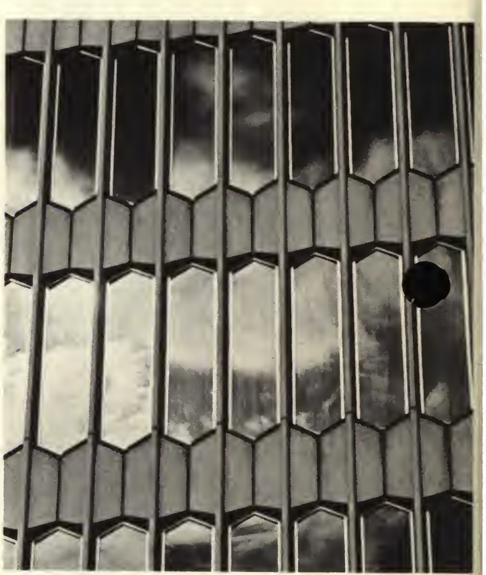
When fasteners are used, these should always be of stainless steel. Corrosion products from non-stainless fasteners can streak and mar the entire installation.

Fasteners which go through a metal face must be located carefully so that there will be no distortion when they are pulled tight. Otherwise extra gauge will be needed to resist distortion.

Other means of preventing "dimpling" are the placement of reinforcing pads

Light, 22-gauge stainless steel textured sheets were used for cladding exterior truss wall girders on Pittsburgh's new Five Gateway Center. This economical gauge insures high strength plus long-term beauty in a corrosive atmosphere at a cost which was 5% under the low bid for another architectural metal.

Architects: Curtis & Davis

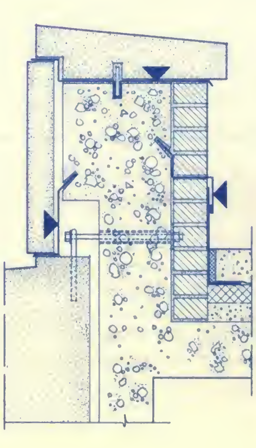


The 4800 slender hexagonal windows of Detroit's Michigan Consolidated Gas Building were fabricated from two roll-formed stainless steel sections—a main frame and a snap-on interior trim. Using a new bending operation which eliminated much welding of the frames, and special installation clamps, the windows were produced at a cost which was competitive with other materials.

Architects: Minoru Yamasaki — Smith, Hinchman & Grylls

Although to all appearances a masonry building, Philharmonic Hall, New York, contains some 25,000 pounds of stainless steel flashing and 60,000 stainless masonry fasteners. Type 302 stainless was chosen for both of these applications because it will not form corrosion products that could stain the light beige marble facing. Drawing of cornice (left) shows three installations of flashing as well as a specially designed anchor holding cornice stone to parapet wall.

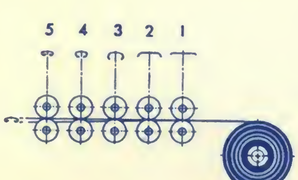
Architects: Harrison and Abramovitz.



Nowhere is a building's appearance more important than at ground level. Stainless steel's ability to absorb rough treatment from weather and traffic abuse makes it the preferred material for interior and exterior ground level treatment, illustrated by the window mullions and entrances in the Michigan Consolidated Gas Building.

Architects: Minoru Yamasaki—Smith, Hinchman & Grylls

Typical power brake forming tooling. Dies shown in blue.



Stages of formation in typical roll forming operation.

under screw heads, and the use of a hat channel on the inside of a metal component. In the latter case, the nut is fastened to the hat channel so that the pull of the fastener is disributed over a large area of the metal face.

FABRICATION METHODS

Stainless steel can be fabricated by all standard methods used for metal including casting, machining, stamping, spinning and extruding. Most widely used methods for the fabrication of architectural components of sheet and strip metal are brake forming and roll forming.

Brake forming is a manually fed bending operation utilizing a relatively simple hand or power-operated brake press. Although designs must be simple, formation can be on one, two, or (to a limited extent) three planes. This is the most economical method if a small number of pieces are to be formed.

Roll forming is an automated, continuous process using special roller-die equipment. This is the most economical method for forming a large quantity of pieces, and is widely used in manufacturing stock window and curtain wall framing components.

In recent years the cost of stainless steel components has been decreasing to the point where it is competitive with other metals. This is partly due to increased use of roll forming equipment by fabricators of stainless steel components. Equally responsible is the growing tendency of architects and specification writers to write performance type rather than construction type specs. Specifications which require stainless sections as thick as aluminum ones put an unnecessary cost disadvantage on the stronger stainless. Performance type specs are based on putting strength where it is needed. The result: stainless steel's greater strength is used to full advantage, thus reducing costs.

DESIGNING FOR MINIMUM MAINTENANCE

Design considerations can assist stainless steel's superior wear and corrosion-resisting characteristics in reducing long-term maintenance costs. On exterior applications out of easy reach, where air-borne dirt accumulations cannot be prevented, good design can reduce maintenance requirements. In this connection, the following suggestions are offered:

1. Use the smoothest finish, whether flat or textured, that will provide the desired appearance and necessary rigidity.

2. When textures or patterns are indicated, use impressions in the vertical direction. Horizontal shapes collect more dirt, can cause uneven streaking.

3. Avoid designs that concentrate flow of water on an exterior surface. Massive overhangs that project beyond lower building areas should be avoided to prevent streaking with dirt-laden water. These massive overhangs will also shield surfaces below from the natural cleaning action of rain.

4. Avoid or minimize flat horizontal surfaces such as window sills and soffits, or channel dirt drainage through drips and weep holes. Drainage should be confined to the rear of panels.

5. In designing joints, provide drainage for water that may penetrate. Joint faces should include a device to eliminate capillary action.

6. Eliminate drainage from other materials, such as chloride-bearing cements, slag roofs and other corrosive materials.

7. Avoid direct contact between stainless steels and other less corrosion-resistant metals such as carbon steel and zinc. Under certain conditions, e.g. in the extended presence of poorly drained contaminated water, electrolytic action may result and the less corrosion-resistant metal may suffer accelerated corrosion through galvanic attack.

TO ELIMINATE DISTORTION

Whenever a light gauge reflective material is used over a broad area, optical distortion or "oil canning" may be a problem. Any of the following steps can be taken to avoid oil canning when designing in stainless:

1. Use slight concave panels to eliminate all flat reflective surfaces.

2. Back light gauge stainless sheet with a stiff material such as composition or asbestos board.

3. Use a panel with a shallow, diepressed design.

4. Break up the reflective surface by using textured stainless steel or by using a less reflective finish.

5. Specify a relatively heavy gauge, so there will be no danger of buckling.

An outstanding example of stainless steel's durability in a corrosive urban atmosphere can be seen in the Chrysler Building tower, New York City, constructed in 1930 and shown being cleaned for the first time in 1961. After inspecting the Type 302 sheathing, the American Society for Testing and Materials reported: "The surfaces of the tower were covered with dirt but under the dirt there were practically no indications of pitting."
Architect: William Van Alen

New York's Empire State Building was erected in 1931 with stainless steel tower pilasters and mullions. A 1960 inspection report by ASTM stated: "From all indications, there has been practically no deterioration of the stainless steel since its erection 29 years ago. From a distance, in spite of adhering dirt, the stainless steel shines brightly."
Architects: Shreve, Lamb and Harmon

Effective cleaning methods

CONDITION	CLEANSING* AGENT	METHOD OF APPLICATION†
For normal atmospheric and construction dirt	Soap, or ammonia, or detergent and water	Sponge or rag; rinse with clear water; wipe dry
For heavier dirt containing oil or grease	Organic solvents: ether, acetone, alcohol, benzol, benzine, xylol, etc.	Sponge or rag; rinse with clear water; observe safety rules
	5 to 15% caustic soda, 6% solution of sodium metasilicate, trisodium phosphate, etc.	Same as above
For rust discoloration from other materials	Oakite #33, one part in two parts water	Clean cloth or sponge; let stand 20 min; rinse; repeat and let stand longer if necessary
For deposits which require scouring **NOTE:** Always rub in the direction of the finish grain in the metal. In extreme cases, stainless steel wool can be used. Never employ regular steel wool.	Grade FFF Italian pumice, whiting, Bon Ami	Rub with damp cloth
	Liquid Nu-Steel Perma-pass	Rub with small amount on dry cloth
	Steel Bright	Rub with small amount on dry cloth
	Paste Nu-Steel or DuBois Temp	Rub with small amount on dry cloth
	Cooper's Stainless Cleaner	Rub with damp cloth
	Allen Stainless Steel Polish	Rub with damp cloth
	Household cleaners: Bab-O, Old Dutch, Sunbrite, etc.	Rub with damp cloth

* Use of proprietary names is intended only to indicate a type of cleaner, and does not constitute endorsement or warranty by the Committee or The International Nickel Company, Inc.

† Reference should be made to the manufacturer for more complete information on methods of application, use and precautions.

NOTE: On occasion, temporary protection such as pressure sensitive paper or strippable plastic films are applied to prevent inadvertent damage during installation. These coatings may tend to age and lose their toughness and strippability. Consequently, when there is any prolonged storage or exposure involved, their condition should be checked at increasingly frequent intervals.

For further information on stainless steels and additional supplies of this Fact Sheet, contact Committee of Stainless Steel Producers, 633 Third Avenue, New York 17, N. Y.

COURTESY OF

THE INTERNATIONAL NICKEL COMPANY, INC.

67 WALL STREET, NEW YORK, N. Y. 10005

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